STATE OF MISSOURI
DEPARTMENT OF NATURAL RESOURCES
AIR POLLUTION CONTROL PROGRAM
205 JEFFERSON STREET, P.O. BOX 176
JEFFERSON CITY, MISSOURI 65102

EMISSIONS INVENTORY QUESTIONNAIRE (EIQ)

FORM 2.6 ORGANIC LIQUID STORAGE - FLOATING ROOF TANK

SHADED AREAS FOR OFFICE USE ONLY

FACILITY NAME	FIPS COUNTY NO.	PLANT NO.	YEAR OF DATA

PLEASE PROVIDE ALL THE FOLLOWING INFORMATION IF THIS FORM IS BEING USED TO DERIVE EMISSION FACTORS FOR A LIQUID STORAGE TANK WITH CAPACITIES GREATER THAN 250 GALLONS. PLEASE INCLUDE ALL ORGANIC LIQUIDS AND PETROLEUM PRODUCTS OR FUELS.

[1] TANK INFORMATION

POINT (TANK) ID NO. / AIRS ID-PT	TYPE OF CONSTRUCTION ☐ RIVETED ☐ WELDED	PRIMARY SEAL ☐ METALLIC SHOE ☐ LIQUID-MOUNTED ☐ VAPOR MOUNTED
CAPACITY (IN THOUSANDS OF GALLONS)	TYPE OF ROOF ☐ INTERNAL ☐ EXTERNAL	
DIAMETER (FT.)	LENGTH OF SEAM (FT)	SECONDARY SEAL ☐ NONE ☐ SHOE MOUNTED ☐ RIM-MOUNTED ☐ WEATHER SHIELD
SEAL FACTORS, A&B	NUMBER OF COLUMNS	
CLINGAGE FACTOR	EFFECTIVE COLUMN DIAMETER (FT)	AREA OF DECK (SQ FT)
SHELL CONDITION ☐ LIGHT RUST ☐ DENSE RUST ☐ GUNITE LINED	DECK ☐ BOLTED ☐ WELDED	TOTAL FITTING LOSS FACTOR (LB-MOLE/FT-YR)
		SEAM LOSS FACTOR (LB-MOLE/FT-YR)

[2] CHEMICAL INFORMATION

CHEMICAL	THROUGHPUT (1,000 GAL/YR)	VAPOR PRESSURE AT STORAGE TEMP (PSIA)
VAPOR MOLECULAR WT	NUMBER OF TURNOVERS	**VAPOR PRESSURE FUNCTION** = [{VAPOR PRESSURE} / 14.7] / [1 + (1 - ({VAPOR PRESSURE} / 14.7))ˆ0.5]ˆ2
LIQUID DENSITY (LB/GAL)	PRODUCT FACTOR	=

[3] METEOROLOGICAL CONDITIONS

AVERAGE WIND SPEED (MPH)	SEAL RELATED WIND EXPONENT	AVERAGE AMBIENT TEMPERATURE (F)

[4] VOC EMISSION CALCULATIONS

RIM SEAL LOSS (LBS/YR)	WITHDRAWAL LOSS (LBS/YR)
RIM SEAL LOSS = (SEAL FACTOR, a + SEAL FACTOR, b X {AVG. WIND SPEED}ˆ{SEAL RELATED WIND EXPONENT}) X {DIAMETER} X {MOLECULAR WT} X {PRODUCT FACTOR} X {VAPOR PRESSURE}	WITHDRAWAL LOSS = 0.943 X ({THROUGHPUT} X 23.81) X {CLINGAGE FACTOR} X {LIQUID DENSITY} / {DIAMETER} X [1 + ({NO. OF COLUMNS} X {EFFECTIVE COLUMN DIAMETER} / {DIAMETER})]
=	=

DECK FITTING LOSS (LBS/YR)	DECK SEAM LOSS (LBS/YR)
DECK FITTING LOSS = {TOTAL DECK FITTING LOSS FACTOR} X {MOLECULAR WT} X {PRODUCT FACTOR} X {VAPOR PRESSURE FUNCTION}	DECK SEAM LOSS = {DIAMETER}ˆ2 X {LENGTH OF SEAM} / {AREA OF DECK} X {SEAM LOSS FACTOR} X {MOLECULAR WT} X {PRODUCT FACTOR} X {VAPOR PRESSURE FUNCTION}
=	=

WORKING LOSS EMISSION FACTOR	SCC	BREATHING LOSS EMISSION FACTOR
WORKING LOSS EMISSION FACTOR = {WITHDRAWAL LOSS} / {THROUGHPUT}	WORKING LOSS SCC	BREATHING LOSS EMISSION FACTOR = (RIM SEAL LOSS} + {MOLECULAR WT} + {DECK SEAM LOSS}) / {CAPACITY})
=	BREATHING LOSS SCC	=

DUPLICATE THIS FORM AS NEEDED.

INSTRUCTIONS

FORM 2.6 ORGANIC LIQUID STORAGE, FLOATING-ROOF TANK WORKSHEET

This form is **REQUIRED** if a facility **wants to calculate its own working and breathing loss emission factors** for a floating-roof organic liquid storage tank(s) that has a capacity greater than 250 gallons. A separate Form 2.6 should be used to calculate the emission factors for each individual floating-roof tank (i.e., NO GROUPING OF FLOATING TANKS).

TANKS is a U.S. Environmental Protection Agency (EPA) computer software package that also may be used to calculate tank emission factors. If this software is used, please attach a copy of the printout and list the tank information on Form 2.5L. This computer software may be obtained from the EPA's Technology Transfer Network on the CHIEF Bulletin Board System at (919) 541-5285 or Internet address http://www.epa.gov/ttn/chief/tanks.html or by contacting EPA Region VII at (913) 551-7020.

All of the information concerning the calculation of VOC emission factors for floating-roof storage tanks was taken from the EPA Manual AP-42, Section 7. Reading this section from AP-42 may provide a more in-depth explanation of the emission calculations for this type of equipment.

Emissions can occur from floating-roof storage tanks by four mechanisms: rim seal loss, withdrawal loss, deck fitting loss and deck seam loss. This form only applies to freely vented internal floating-roof tanks or external floating roof tanks. This form does not apply to:

1) closed internal floating-roof tanks;
2) unstable or boiling stocks or from mixtures of hydrocarbons or petrochemicals whose vapor pressure is not readily known or cannot readily be predicted;
3) losses from tanks in which the materials used in the seal system and for the deck construction have become deteriorated or significantly permeated by the stored liquid.

NOTE: Tables, Figures and other attachments are not included with these instructions. Please refer to EPA Manual AP-42, Section 7, or contact the Air Pollution Control Program at (573) 751-4817.

Complete **Facility Name, County Number, Plant Number** and **Year of Data.**
See Form 1.0 instructions, page 1.0-1.

1) TANK INFORMATION

Point or Tank Identification Number: This is the unique identification number for each specific floating roof storage tank. This identification must match the point number entered on Form 1.1, Process Flow Diagram; Form 1.2, Summary of Emission Points; and Form 2.0, Emission Point Information.

AIRS ID-Pt: See Form 2.0 instructions.

Capacity (in Thousands of Gallons): The tank capacity should be expressed in thousands of gallons of liquid. A 10,000-gallon storage tank should be entered as 10 in this box.

Diameter: Enter the diameter of the storage tank in feet.

Seal Factor, a & b: These factors are based on the emissions from the type of seal(s) on the connection between the floating roof and the storage tank. The values for the seal factors, a & b may be found in the K_{Ra} and K_{Rb} columns of Table 7.1-8.

Clingage Factor: This factor is the tendency of the liquid to remain on the walls of the storage tank after emptying the tank. This factor is related to the shell condition of the tank.

The value for the clingage factor can be found in Table 7.1-10 below.

TABLE 7.1-10 AVERAGE CLINGAGE FACTORS (C) (bbl/1,000 ft^2)

Liquid	Shell Condition [a] Light Rust	Dense Rust	Gunite Lined
Gasoline	0.0015	0.0075	0.15
Single component stocks	0.0015	0.0075	0.15
Crude oil	0.0060	0.030	0.60

[a] If no specific information is available, these values may be assumed to represent the most common or typical condition of tanks currently in use.

Shell Condition: Check the box that most appropriately describes the shell condition of the storage tank. The shell condition is used to determine the clingage factor for the organic liquid stored in the tank.

Type of Construction: Check the box that most appropriately describes the floating-roof tank construction. This will normally be either riveted or welded.

Type of Roof: Check the box that describes the type of roof on the floating-roof storage tank.

Length of Seam: Enter the total length of the deck seam for bolted decks on internal floating-roof tanks only. If the total length of the deck seam is not known, Table 7.1-16 may be used to determine the {Length of Seam}/{Area of Deck} component (Deck Seam Length Factor) of the Deck Seam Loss Calculation. For a deck constructed from continuous metal sheets with a 7-ft spacing between the seams, a value of 0.14 ft/ft^2 may be used for the above Deck Seam Length Factor. A value of 0.33 ft/ft^2 may be used for the Deck Seam Length Factor when a deck is constructed from rectangular panels 5 ft by 7.5 ft. Where tank-specific data concerning width of the deck sheets or size of deck panels is unavailable, a default value for the Deck Seam Length Factor may be assigned. A value of 0.20 ft/ft^2 may be assumed to represent the most common bolted decks currently in use.

Number of Columns: This value represents the number of columns that support the floating roof. Note: The Number of Columns equals zero (0) for self-supporting fixed roofs or external floating-roof tanks. For column-supported fixed roofs, use tank-specific information or a figure obtained from Table 7.1-11 for this storage tank.

Effective Column Diameter: This value is the effective size of the diameter of a column, expressed in feet. The effective column diameter may be found by taking the circumference of the column and dividing by mathematical pi (3.1416). Note: Tank-specific effective column diameter information should be used or a default value of 1.1 for 9-by-7-inch built-up columns may be used for this figure, or a default value of 0.7 may be used for 8-inch diameter pipe columns. A value of 1.0 should be used if the column construction details are not known.

Deck: Check the appropriate box for the type of deck construction. Neither welded deck internal floating roof tanks nor external floating roof tanks have deck seam losses and the deck seam losses and the deck seam loss emissions should be entered as zero. Internal floating roof tanks with bolted decks may have deck seam losses.

Primary Seal: Check the primary seal type that is most consistent with the primary seal for this specific storage tank.

Secondary Seal: Check the secondary seal type that is most consistent with the secondary seal for this specific storage tank.

Area of Deck: Enter the area of the deck of the storage tank in square feet. See the Length of Seam field explanation if specific information on the Area of the Deck is not available.

Total Deck Fitting Loss Factor: This factor is based on the emissions that can result from various types of fittings and other attachments on the deck.

For External Decks:

The value for the Total Deck Fitting Loss may be calculated using the actual tank-specific data for the number of each fitting type and then multiplying by the fitting loss factor for each fitting according to the following formula:

Total Fitting Loss Factor $= \{(N_{F1}*K_{F1}) + (N_{F2}*K_{F2}) + \cdots + (N_{Fn}*K_{Fn})]$

Where N_{Fi} is the number of roof fittings of a particular type ($i = 0,1,2,3 \ldots, n_f$)
K_{Fi} is the roof fitting loss factor for a particular fitting ($i = 0,1,2,3 \ldots, n_f$)
(See discussion below)
n_f is the total number of different types of fittings

The roof fitting loss factor for a particular type of fitting, may be estimated by the following equation:

Roof Fitting Loss Factor for a Fitting $= K_{Fai} + (K_{Fbi} * \{\text{Avg. Wind Speed}\}^{mi})$

Where K_{Fai} is the loss factor for a particular type of fitting in lb-moles/yr;
K_{Fbi} is the loss factor for a particular type of fitting in lb-mole/(mph)^{m}yr
mi is the loss factor

Loss factors for the above equation are provided in Table 7.1-12 for most common roof fittings used on external floating roof tanks. Typical numbers of fittings are presented in Tables 7.1-12, 7.1-13, and 7.1-14. Where tank-specific data for the number and type of deck fittings are unavailable, values for the fitting loss factor may be obtained from Figures 7.1-23 and 7.1-24. The values presented in Figures 7.1-23 and 7.1-24 present the total fitting loss factor plotted against tank diameter for pontoon and double-deck external floating roofs, respectively.

For Internal Decks:

The value for the Total Deck Fitting Loss may be calculated using the actual tank-specific data for the number of each fitting type and then multiplying by the fitting loss factor for each fitting according to the following formula:

Total Fitting Loss Factor $= \{(N_{F1}*K_{F1}) + (N_{F2}*K_{F2}) + \cdots + (Nfn*KFn)]$

Where N_{Fi} is the number of roof fittings of a particular type ($i = 0,1,2,3 \ldots, n_f$)
K_{Fi} is the roof fitting loss factor for a particular fitting ($i = 0,1,2,3 \ldots, n_f$)

n_f is the total number of different types of fittings

Values of the deck fitting loss for a particular fitting type and the typical number of fittings are presented in Table 7.1-12 for internal floating roof decks. Where tank-specific data for the number and kind of deck fittings is unavailable, the loss factor may be approximated according to the tank diameter. Figures 7.1-25 and 7.1-26 present the Total Fitting Loss Factor plotted against tank diameter for column-supported fixed roofs and self-supported fixed roofs, respectively.

Seam Loss Factor: A value of 0.0 should be used for welded decks and external floating roof tanks. A value of 0.14 should be used for bolted decks.

2) CHEMICAL INFORMATION

Chemical: Enter the name(s) of the chemical(s) stored in the tank during the calendar year.

Vapor Molecular Weight: Enter the molecular weight of the vapor for the specific chemical stored in the tank during the year expressed in pounds per pound-mole. If more than one chemical was stored in the tank at separate times during the year, then complete a separate Form 2.6 for each material.

The vapor molecular weight for selected petroleum and volatile organic liquids may be determined from Tables 7.1-2 and 7.1-3, respectively or by analyzing vapor samples. If the tank contains a mixture of different liquids, with each liquid denoted by a, b, . . . z, then the following equation should be used for calculating the vapor molecular weight of the mixture:

$$\text{Vapor Molecular Weight} = M_a(P_aX_a/Pt)+M_b(P_bX_b/Pt)+\cdots+M_z(P_zX_z/Pt)$$

where M_a, M_b, . . . M_z are the molecular weights of the respective compounds in the liquid. X_a, X_b, . . . X_z represent the respective mole fraction of each component of the liquid. P_a, P_b, . . . P_z represent the respective true vapor pressures of each different liquid. Pt is the total vapor pressure. Raoult's Law, shown below, may be used to find total vapor pressure.

$$Pt=P_aX_a+P_bX_b+\cdots+P_zX_z$$

AP42, Section 7.1 provides a more detailed discussion on this topic.

Liquid Density: This value should be available from the Material Safety Data Sheets provided by the supplier for the specific material associated with this emission point. If the specific gravity is given on the MSDS (Material Safety Data Sheet), multiply the specific gravity by 8.34 to obtain the density expressed in pounds of material per gallon of liquid. A listing of the average organic liquid densities for selected petrochemicals is provided in Tables 7.1-2 and 7.1-3. If the liquid density for gasoline is not known, an average value of 6.1 lbs/gallon can be assumed.

Annual Throughput: This value is the annual amount of the organic liquid that has been stored in the storage tank during the calendar year. This value must be expressed in thousands of gallons of liquid stored during the year. The following conversion factors should be used if the annual throughput is normally expressed in barrels. There are 42 gallons per barrel for U.S. petroleum products and 31.5 gallons per barrel for other U.S. liquids.

Number of Turnovers: Calculate this entry by dividing the Annual Throughput by the Tank Capacity. Express both values in thousands of gallons.

Product Factor: This factor is a dimensionless number which, for crude oil, is 0.4. For all other organic liquids, the product factor default value is 1.0.

Vapor Pressure at Storage Temperature: Enter the vapor pressure in pounds per square inch (absolute psia) for the liquid being stored at bulk liquid surface temperature.

> ***NOTE:*** If the liquid stored in the tank is listed in Table 7.1-3, use the true vapor pressure listed there. If the liquid stored is not listed on Table 7.1-3, then the true vapor pressure may be estimated using Antoine's Equation. AP42, Section 7.1 has more information on how to calculate the true vapor pressures for organic liquids using Antoine's Equation.

For Crude Oils

Use Figure 7.1-13a or 7.1-13b to calculate the true vapor pressure of the crude oil if the Reid vapor pressure is known. First find the stored liquid temperature (in Fahrenheit) on the scale at the right side of the page. Then locate the Reid vapor pressure of the liquid on the scale that is in the middle of the figure. Next, draw a straight line from the stored liquid temperature, through the Reid vapor pressure point, to the true vapor pressure at the left side of the figure. Enter the true vapor pressure reading that is indicated on the scale that is on the left side of the page.

For Refined Petroleum Stocks

The true vapor pressure values for some refined petroleum products may be obtained from Table 7.1-2. Figure 7.1-14a or 7.1-14b may be used to find the true vapor pressure if the Reid vapor pressure is known. First find the stored liquid temperature on the scale at the right of the page. Second, locate the approximate position for the Reid vapor pressure, using the slope of the distillation curve on the small graph in the center of the page. Finally, line up these two points and extend a straight line to the true vapor pressure scale at the left side of the page. Enter this value as the true vapor pressure of the liquid.

Vapor Pressure Function: This can be calculated using the following equation:

$$P^* = \frac{P_{VA}/P_A}{[1 + (1 - [P_{VA}/P_A])^{0.5}]^2}$$

where:

P_{VA} = vapor pressure at daily average liquid surface temperature, psia;
P_A = atmospheric pressure, psia.

P* can be read directly from Figure 7.1-19.

3) METEOROLOGICAL CONDITIONS

Average Wind Speed: This value is the average wind speed at the tank site, expressed in miles per hour. The average wind speed numbers should be used for the areas surrounding the specific cities listed in the table below. A default value of 10 miles per hour may be used for all other locations if other site specific information is not available.

Cities	Average Wind Speed (mph)
Columbia	9.9
Kansas City	10.8
Saint Louis	9.7
Springfield	10.7

Seal Related Wind Speed Exponent: The value for the Seal Related Wind Speed Exponent may be obtained from the (n) column of Table 7.1-8.

Average Temperature: This value is the average temperature at the tank site expressed in degrees Fahrenheit. A default value of 54.5 degrees Fahrenheit may be used if other information is not available.

4) VOC EMISSION CALCULATIONS

Rim Seal Loss: This equation calculates the portion of the VOC emissions that results from losses around the rim seal of a floating roof storage tank, expressed in pounds of VOC lost per year. The Rim Seal Loss emissions from floating roof tanks with a(n) "INTERNAL" roof or "DOMED EXTERNAL" roof are not dependent on the wind speed. Therefore, the {Average Wind Speed}^ {Seal Related Wind Exponent} portion of the equation should be set to 1 (one) when calculating the Rim Seal Loss emissions. Enter the results of the calculation in the box directly below the Rim Seal Loss formula on Form 2.6.

Withdrawal Loss: This equation calculates the portion of the VOC emissions that results from filling and emptying the floating roof storage tank. Express this value in pounds of VOC lost per year.

For "EXTERNAL" Floating Roof Tanks

The **[1 + ({No. of Columns} x {Effective Column Diameter} / {Diameter})]** portion of the equation should be set to 1 (one) when calculating the Withdrawal Loss. Enter the results of the calculation in the box directly below the Withdrawal Loss formula on Form 2.6. **Note**: The factor of 23.81 used in this equation converts from thousands of gallons to barrels for the Annual Throughput of petroleum products. If a non-petroleum liquid is being stored in the tank, a value of "31.75" should be substituted for the "23.81" figure.

Deck Fitting Loss: This equation calculates the portion of the VOC emissions that results from the Deck Fitting Losses from fittings and other attachments on the deck of the floating roof storage tank. Express this value in pounds of VOC lost per year. Enter the results of the calculation in the box directly below the Deck Fitting Loss formula on Form 2.6.

Deck Seam Loss: Neither internal floating roof tanks with welded decks nor external floating roof tanks have deck seam losses. Internal floating roof tanks with bolted decks may have deck seam losses. Enter the results of the calculation in the box directly below the Deck Seam Loss formula on Form 2.6.

Working Loss Emission Factor: Compute the Working Loss Emission Factor by dividing the Withdrawal Loss by the Annual Throughput (expressed in thousands of gallons) from

Block 2, Chemical Information. This will give an emission factor in pounds of VOC emitted per thousand gallons of an organic liquid processed annually.

Breathing Loss Emission Factor: Compute the Breathing Loss Emission Factor by adding the Rim Seal Loss, Deck Fitting Loss and Deck Seam Loss together. Divide by the Capacity (expressed in thousands of gallons) from Block 1, Tank Information. This will give an emission factor in pounds of VOC emitted per thousand gallons of an organic liquid stored annually.

Enter the SCC for both **Working Loss** (Withdrawal Loss) and the **Breathing Loss** (Standing Loss) in the appropriate boxes next to the Emission Factors.

ENTER THE FOLLOWING ON FORM 2.0, EMISSION POINT INFORMATION:

NOTE: USE A SEPARATE FORM 2.0 FOR THE WORKING AND BREATHING LOSS EMISSION FACTOR.

Block 4 - Enter **Annual Throughput** (Thousands of gallons).
Block 7 - Enter the **Working Loss Emission Factor** or the **Breathing Loss Emission Factor** in the VOC box.